Allen (H.)

SPEECH WITHOUT A LARNYX.

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SPEECH WITHOUT A LARYNX.[1]

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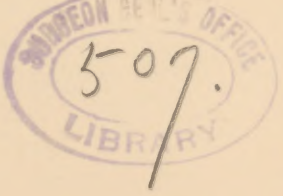
I HAVE the honor to report the following facts in the case of Daniel Hickey. This man talks after the removal of the larynx. The operation was performed for epithelioma by Dr. J. Solis Cohen at the Jefferson College Hospital, April 1, 1892.[2] Dr. Cohen informs me that the parts removed included the entire larynx (excepting the free portion of the epiglottis). The first ring of the trachea was removed with the larynx, and the second was stitched to the skin of the front of the neck.[3]

The patient was mute after the operation for nearly a year, when speech returned. Inspection of the external part of the neck showed a T-shaped scar extending from the tracheal opening to near the position of the hyoid bone. The greater part

[1] A report of an investigation made at the instance of the College of Physicians of Philadelphia, and presented March 7, 1894.

[2] See Trans. Phila. County Medical Society, vol. xiii, 1892, p. 302; also Trans. College of Physicians of Philadelphia, 3d Series, vol. xv, 1893, p. 131.

[3] A brief reference to the operation will be found in THE MEDICAL NEWS of July 23, 1892, p. 98: and a reference to the subsequent course of the case in THE NEWS of February 18, 1893, p. 195.



of this region was occupied by a sac of irregular shape, measuring about 45 mm. in length by 26 mm. in width, whose anterior wall was the integument, and which could be easily pressed back against a resistant surface, which was doubtless that of the cervical vertebræ. The skin, which in part was occupied by scar-tissue, was perforated near the junction of the level of the old transverse and longitudinal incisions by a minute fistulous track. Bubbles of air and a little mucus escaped from this opening. Owing to the prominence of the bellies of the sterno-cleido-mastoidei muscles the sac was in a depression whose lateral boundaries were not fixed. The sac-wall apparently had no muscular power, and was exceedingly flaccid. It will be seen that it moved freely from slight forces exerted within the mouth and pharynx. Its size varied only with the amount of air or fluid it contained. The tracheal opening was red in color, and apt to be coated by scales of inspissated mucus. The position of three rings of the trachea could be made out by the unevenness of the tracheal surface rather than by any contrasted effects of colors. The trachea moved slightly (synchronously with the pulsations of the heart) from left to right.

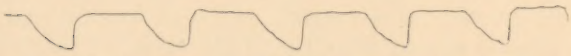
Examination with a laryngeal mirror, placed as in the position usual for laryngoscopy, showed the base of the tongue and the epiglottis to be normal. The epiglottis was large, broad, and but slightly depressed in the center. It stood erect. A deep, funnel-shaped depression, answering to the interior of the sac, extended from the pharynx downward. No details could be detected within the sac other

than a small scar-like structure at the posterior border of the aperture. This appeared to be most distinct at the time of a deep inspiration. I speak here of the *time* of the inspiration, and not of the assumed passage of air from the pharynx into the sac. When the nostrils were closed, the mouth open, the tongue protruded, and a film of mucus was stretched across (as was often the case) from the tongue to the velum palati, it was interesting to note that the film would persist for an indefinite period, thus proving that no air entered the sac during respiration. Forcible closure of the nostrils would often cause the film to bulge forward and break. I assume that the displacement of the air from the nose had slightly compressed that in the pharynx. The sac was seen to be easily closed by pressure from without, the two lips came together, and the whole space was obliterated. The fistulous track through the wall of the sac was valvular. A probe passed through it was easily discerned in the pharynx. The outer end of the fistula being covered with plaster, and the nostrils and mouth closed, the sac could be distended so as to become convex anteriorly. I assume this was caused by elevation of the base of the tongue and velum, and consequent displacement of the air of the mouth and pharynx downward.

The respiratory phenomena, although not subjected to precise experiment, appeared to be normal. The patient breathed from nineteen to twenty-two respirations per minute. The chest-expansions were free and unimpeded. A tambour being held in contact with a lever placed on the sac, and so

arranged as to transmit impulses to a second tambour so disposed as to have its movements recorded on a kymographion, was found to make a downward tracing during the act of respiration, while the form of the sac did not change in shape. I conclude that these movements were secondary. The changes here noted were due to the motions of the neck itself during the act of respiration, and were probably related to the elevation of the clavicles and the upper part of the thorax. (Fig. 1.)

FIG. 1.



Respiratory curves made by motions transmitted by the neck to level placed on sac.

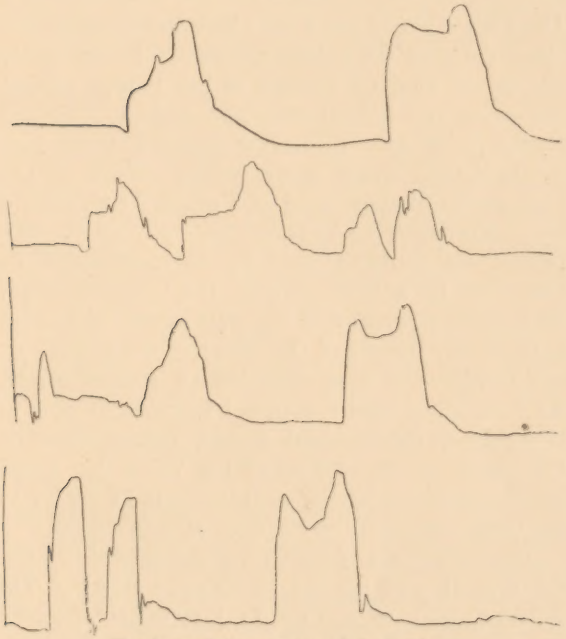
The act of swallowing was performed with comparative ease, though food was apt to pass into the sac. Liquids flowed out readily from the fistula. Pressure on the sac with the finger prevented the passage of both solids and liquids, and this pressure was regularly employed by the man in eating and drinking. The tracing made on the kymographion varied exceedingly, and appeared to be due to inconstant use of the tongue and pharyngeal muscles. Some of the tracings of deglutition are herewith given. (Fig. 2.)

The voice appeared to be true, as opposed to a whisper. It was thin, harsh, and weak, though estimated by Dr. Cohen to be heard at forty feet. Wheezy sounds of air escaping from the lung occurred coincidently with speech.

The voice was fairly well modified, and was capable

of slight shades of expression. The patient could sing a song, and while the musical character of the performance was *nil*, the difference in tone between the attempt at singing and ordinary utterance was evident.

FIG. 2.



Tracings of the variants of deglutition.

In studying the phenomena of speech the first experiments were directed to the tongue and velum. I repeated the observations of Dr. N. Kingsley to ascertain after what manner the tongue was used in

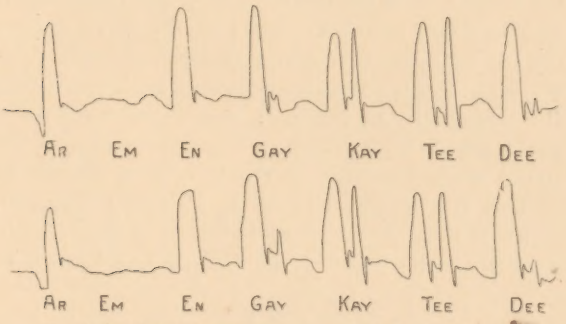
articulation. I secured the assistance of Dr. W. Christensen, a dentist in this city, who kindly prepared a number of vulcanite plates. Coating one of these with a mixture of alcohol and prepared chalk, and placing it in the roof of the mouth, I directed the patient to pronounce the letters of the alphabet. The tongue wiped away the chalk and exposed the black color of the rubber beneath. It was easily ascertained that the contact of the tongue against the velum and palatal vault was made in a normal manner, the only difference between those thus obtained and those made in the mouth of Dr. Christensen himself being of a character that could be readily explained by individual peculiarity. The patient was rendered mute by the insertion of the plate, but by a little practice the voice returned. The slightest pressure of the plate against the velum immediately destroyed the power of utterance.

The voice was next recorded on a phonograph. This was done with the object in view not only of eliminating the tracheal noises, but of catching the shades of distinction of the voice that could not be detected by the unaided ear. I regret to say that these experiments were without results.

The third series of observations consisted in careful inspection of the sac during enunciation. The following facts were elicited: Just before speaking the patient inspired; then at the time of talking (the pronunciation of definite simple sounds was practised) the sac filled and emptied. The levers with tambours were here used, and their movements were recorded on a kymographion, as in the case of the respiratory movements. All of the speech-trac-

ings were upward, and were thus quite unlike those of respiration. (Fig. 3.) Filling of the sac occurred in all the consonants in which *e* (*i. e.*, the sound made in the English alphabet) entered. *G* (gay) produced, as was expected, a maximum amount of movement in the sac-wall. The least constant movement occurred in *m* (em). While engaged in repeating these sounds it occurred to me that it

FIG. 3.

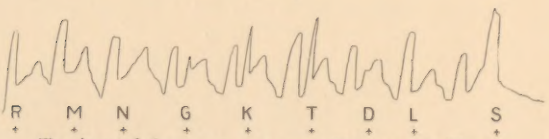


Tracings of consonants *r*, *m*, *n*, *g*, *k*, *t*, *d*—Continental pronunciation.

would be convenient to have a number of phonetic characters arranged in the order of their formation from the throat toward the teeth, and I accepted the following as fairly representative of such a series: *r*, *m*, *n*, *g*, *k*, *l*, *s*, *t*, *d*. All observations were made with the patient reading aloud these letters from a chart placed in front of him, while the head was supported to eliminate all body-movements. It was soon noticed that the movements in *m* were the least constant, and the sac-movements were influ-

enced by the act of respiration. If a full inspiration were taken, and *g* pronounced and *m* followed, scarcely any motion ensued in the sac, while if, after a full inspiration, *m* was at once pronounced the sac-walls moved almost as freely as in the pronunciation of any other sound. At the same time it was evident that while neither the air of inspiration nor that of expiration was used, the patient could speak only during expiration. I recognized the subject to be complex. The difficulties in maintaining exact uniform contact of the lever against the sac were considerable, and had not been overcome at the time the experiments were interrupted. But this much can be said: that the movements of the sac-wall were freest in the formation of the sound when the base of the tongue is known to assume the largest size (*i. e.*, humping upward), and that they were limited in range or entirely absent when the base of the tongue was known to

FIG. 4.

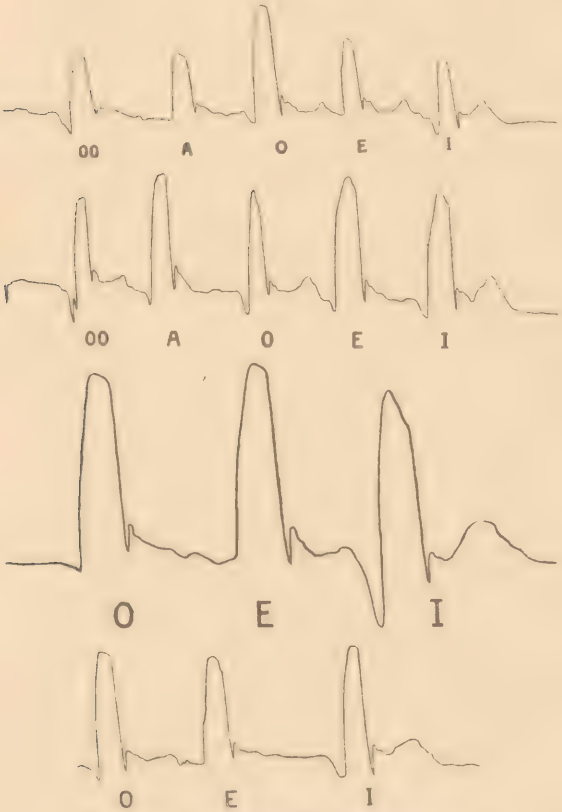


Tracings of the same consonants illustrated in Fig. 3. The crosses represent the times of expiration.

move upward the least in the manner described; therefore, that the times of enunciation and those of movements of the sac were synchronous, and that a direct connection existed between the movements of the sac and those of the tongue. In a word, the movements of the sac-wall were due to com-

pression of air in the sac, due in its turn to displacement of air in the mouth and pharynx. (Fig. 4.)

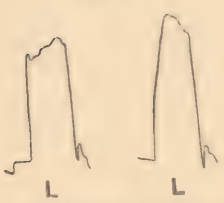
Fig. 5.



Variants of the tracings of the vowel sounds. Continental pronunciation.

Enunciation of the vowels permits air to pass through the mouth through relatively wide apertures as compared with enunciation of the consonants. Among the vowel-tracings I secured, as a rule, a single curve. (Fig. 5.) The variations were sufficient to lead one to suspect that oscillation was a disturbing tor. Yet, when allowance is made for this error, the tracings are seen to be broadly contrasted with those of the consonants, and the semi-vowels *l* and *r* to be (as they should be) quite like the vowels (Figs. 6, 7.)

Fig. 6.



Variants of the letter *l*.

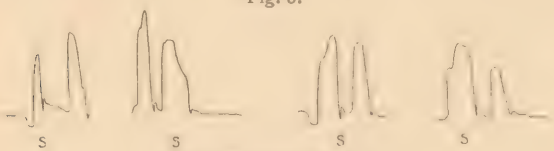
Fig. 7.

Variants of the letter *r*.

Enunciation of the consonants permits air to pass through the mouth with difficulty, if at all, and we find with them a disposition to form a double tracing, excepting in the case of *m* and *n*. The fact that *n* sometimes has a semi-vowel value probably accounts for its curve being at times like that of a vowel. Further investigation will be demanded to settle this point. I thought I had secured a uniform, constant value for this letter, but I may have been mistaken. As a rule, it may be said that the greater the resistance to the outward flow of air the more striking become the sac-movements. As can be surmised, these were greater with surds

than with sonants, and therefore were greater with *t* than with *d*, and were marked with the sibilant *s*. (Fig. 8.)

Fig. 8.



Variants of the letter *s*.

Stimulated by these observations, I was about to institute a carefully devised series of tracings based on the tenets of phonology, when the investigation came to an end.

The relation which existed between the distention of the sac and the movement of respiration and in pronouncing *m* remains unexplained, as indeed did the following curious observation: Occlusion of the tracheal opening, care having been taken to avoid any pressure on the sac, at once arrested speech. I tried this experiment many times. Again, occlusion of the sac likewise arrested speech. I unfortunately failed to observe if this could be overcome with practice, as was the case with the use of the vulcanite plate, or whether a whisper might have been developed when the sac was closed.

The views entertained as to the significance of articulate speech make it necessary that a current of air should vibrate against a flexible hem or border. Dr. Cohen informs me that he thought the scar-like band on the posterior aperture of the sac might serve this purpose. I see no reason why this might not at least assist, while the general constriction of

the circular fibers of the inferior and middle pharyngeal constrictors might act as the cause of the speech by the air vibrating against lips of muscle-ridges which existed only at the time that enunciation occurred. The motions of the sac were also to be explained by these constrictions and (as already stated) by the tongue. But why the act of respiration is in any way related to the performance of these acts is not apparent, unless we assume that the muscle-movements are part of a complicated mechanism which demands the participation of the respiratory act as well as the pharyngeal and oral mechanisms, even in the accidental circumstance of the laryngeal apparatus being absent.

The hypothesis that at first sight is reasonable, that the sac fills when the lung fills, and that sound is produced while the sac empties itself during expiration, is in harmony with the physiology of normal speech. But I cannot see how this opinion can be entertained if it be conceded that the sac did not fill during inspiration, and that the respiratory act did not affect it any more than it did any other part of the neck. But the movements of the sac were coequal with the time of enunciation, and while influenced in a measure (as in pronouncing *m*) by the act of respiration, were not dependent upon it. The idea that speech may have occurred during inspiration is suggested by the shape of the respiratory curves on the kymographion, but this was at once invalidated by the fact that the tracheal noises of expiration were always synchronous with speech, while the respiratory curve was downward instead of upward.

I venture to express the opinion that the displacement of air from the pharynx by the constriction of the lower pharynx was nearly normal, and the humping of the lingual base absolutely so. That these produced so great a change in the sac of our patient was due to the absence of a check-mechanism, the larynx itself, which thus acts in the norm as a barrier to the retrocession of the compressed air. In health the vocal bands when adducted form an almost complete barrier to the entrance of air, and in order that the bands themselves be spared from pressure, laryngeal ventricles are provided to receive and hold it. Not only is this the case, but, in the act of swallowing, these sacs may also serve a purpose of accommodating the air, which, being pushed in advance of the ingesta, would be thrown into the trachea were not a special mechanism provided. The muscle constrictors at the laryngeal orifice exist for this purpose in health. It is noted that the epiglottis is not spoken of in this connection as a factor, either in speech or as an aid to prevent the entrance of food into the larynx. It is my opinion that if it held such an attitude it would have exerted some influence in protecting the sac against the entrance of both solids and liquids in the act of deglutition.

While making the statement that the patient had voice, it is tenable that it was a voice created by the presence of an adventitious resonating chamber established in the region of the larynx, and that the utterances were of the nature of whispers reinforced by the air in this sac.